Draft Policy Option For Discussion: F1 Forestland Protection from Developed Uses

1. Policy Description:
    a. Lay description of proposed policy action: Reduce the rate at which existing forestlands and forest cover are cleared and converted to developed uses.
    b. Policy Design Parameters:
        i. Implementation level(s) beyond BAU: 50% acres of forestland saved from expected rates of land clearing, including pinyon juniper and other forestland.
        ii. Timing of implementation: [x] acres of forestland saved from land clearing from [insert start and stop date], including [x] acres saved per year in [2010 and 2020], including any necessary ramp up period.
        iii. Implementing parties: [insert types of land ownerships and governing authorities].
        iv. Other: [define land area targeting criteria, if any.]
    c. Implementation Mechanism(s): Indicate which mechanisms are to be used, and briefly describe the specific approach that is proposed [check applicable items, or postpone to future discussion]
        i. Information and education [?], Technical assistance [?], Funding mechanisms and or incentives [?], Voluntary and or negotiated agreements [?], Codes and standards [?], Market based mechanisms [?], Pilots and demos [?], Research and development [?], Reporting [?], Registry [?], Other [?]

2. BAU Policies/Programs, if applicable:
    a. [Description of existing state, local or private forestland, farmland and open space protection programs, as well as significant tree retention requirements required for developments]

3. Types(s) of GHG Benefit(s):
    a. CO_2: Carbon savings occur when live carbon stocks (trees, shrubs, and some soil organic carbon) are protected from clearing and the associated decay or combustion of cleared biomass. Carbon losses are offset to some extent by the portion of harvested biomass that is converted to durable wood products (carbon storage in product use), and for that portion converted to renewable energy and displaces fossil energy use that otherwise would be used. Because conversion of forestland to developed land uses typically is permanent, replacement biomass

does not grow back on the site to offset removals of live biomass (i.e., to the levels that existed during forest use).

b. CH4: New research indicates that about four percent of the carbon storage benefits of live forests is offset by methane release (Nature 2006). Methane can be released from land filled biomass under anaerobic conditions.

c. N2O, HFC's, SFC's: Not applicable

d. Black Carbon: Emissions of black carbon (soot) result from combustion of biomass from open burning during land clearing, but the heating effect is likely to be offset by the large amount of organic material that is also emitted during biomass combustion (Hansen 1992; CCS 2006).

4. Types of Indirect Benefits and or Costs, if applicable [modify as needed]:

   a. Potential indirect benefits:

      i. Protection of working lands for sustainable wood products use, recreation, cultural and natural heritage.

      ii. Environmental asset protection, including watersheds, wildlife and air quality.

      iii. Reduced costs of infrastructure and services for dispersed or low density development.

      iv. Reduced transportation emissions from increased location efficiency.

   b. Potential indirect costs:

      i. Certain biomass combustion technologies may result in significant air pollution, including…

5. Estimated GHG Savings and Costs Per $MMTCO_2e$:

   a. Summary Table of:

      i. GHG potential in 2010, 2020

      ii. Net Cost per $MMTCO_2e$ in 2010, 2020

   b. Insert Excel Worksheet and forest calculator showing summary GHG reduction potential and net cost

6. Data Sources, Methods and Assumptions:

   a. Data Sources: Carbon stocks and above ground carbon densities are derived from the Forest Inventory Analysis (FIA) volumetric measurements conducted on a five-year cycle by the USDA Forest Service (Aleric 2004). Land cover change data is provided by FIA data and by the USDA Natural Resource Inventory (NRI), also gathered on a five-year cycle (insert NRI cite). Both data sets are based on a system of numerous state level plots that provide periodic measurements of land cover. Carbon densities for soil carbon are based on recent field estimates (Amichev 2004). Estimates of the portion of cleared biomass converted to commercial wood products and energy recapture, including logging and mill residue generation, are provided by field estimates (Birdsey 1996; Row 1996). Marginal displacement coefficients for avoided energy use are provided by the Energy Supply TWG and are derived from regional National Energy Modeling System (NEMS) data provided by the US Energy Information Administration (EIA) (insert cites).

b. Quantification Methods: Conversion of volumetric measures of above ground biomass to carbon is based on tree growth equations provided by the USDA Forest Service and standard conversions of live biomass to dry carbon (Birdsey 2003; Matthews 1993). Inflows and outflows of carbon from land clearing and associated practices are identified in a forest carbon calculator provided by CCS that captures all potential inflows and outflows (full life cycle analysis) of above and below ground biomass, as well as harvested wood products, energy recapture, residue recovery and waste biomass. Inflows and outflows of carbon are adjusted as needed for ecological or program risks. This calculator is attached as a worksheet below.

c. Key Assumptions: Some rangeland carbon estimates are not currently included in forest carbon estimates due to data limitations; however, “Nonstocked” and “Pinion Juniper” forest stands as defined by FIA include many lands classified as “Rangeland” by NRI. Forecasted carbon stock measurements from 2002 to 2020 are based on extrapolations of past trends from 1982-2002 and assume a static continuation of all land cover and land use dynamics during that period. Implementation mechanisms are assumed to be “growth neutral” to avoid offsetting development impacts, i.e. land protection does not result in land clearing in other areas (also referred to as “leakage”). Cost savings from avoided land clearing costs may be contingent on regulatory acceptance of alternative land development approaches, such as conservation design or cluster development.

7. Key Uncertainties:

a. Benefits: The rate at which live biomass stocks would have declined beyond business as usual due to forest health and forest fire risks may be significant. The rate of offsetting development effects from land protection may be sensitive to the design of policy implementation tools.

b. Costs: Regulatory acceptance of alternative development approaches by local governing bodies may affect potential cost savings of avoided land clearing costs.

8. Description of Indirect Benefits and Costs, if applicable: [delete unless further detail is needed]
    a. [?]

9. Description of Feasibility Issues, if applicable: [delete unless further detail is needed]
    a. [Description of program feasibility issues…]

10. Status of Group Approval [TBD – check one]:
    a. Pending
    b. Completed

11. Level of Group Support [TBD – check one]:
    a. Unanimous Consent
    b. Supermajority
    c. Majority
    d. Minority

12. Barriers to consensus, if applicable (less than unanimous consent): [delete unless further detail is needed]
    a. [?]

Draft Policy Option For Discussion: F2 Reforestation/Restoration of Forestland

1. Policy Description:
    a. Lay description of proposed policy action: Expand forest cover (and associated carbon stocks) by regenerating or establishing forests in areas with little or no forest cover at present.
    b. Policy Design Parameters:
        i. Implementation level(s) beyond BAU: [x] acres of forestland regenerated/established at stocking rates of [x percent].
        ii. Timing of implementation: [x] acres of forestland regenerated/established from [2006-2020], including [x] acres regenerated/established per year in [2010 and 2020], including any necessary ramp up period.
        iii. Implementing parties: [insert types of land ownerships and governing authorities].
        iv. Other: [define targeting criteria for land area or forestland type, if any.]
    c. Implementation Mechanism(s): Indicate which mechanisms are to be used, and briefly describe the specific approach that is proposed [check applicable items, or postpone to future discussion]
        i. Information and education [?], Technical assistance [?], Funding mechanisms and or incentives [?], Voluntary and or negotiated agreements [?], Codes and standards [?], Market based mechanisms [?], Pilots and demos [?], Research and development [?], Reporting [?], Registry [?], Other [?]

2. BAU Policies/Programs, if applicable:
    a. [Description of existing tree planting, restoration, or regeneration programs.]

3. Types(s) of GHG Benefit(s):
    a. CO_2: Carbon savings occur when forest carbon stocks (trees, shrubs, and soil organic carbon) are established and sustained above and beyond existing levels.
    b. CH_4: New research (Nature 2006) indicates that about four percent of the carbon storage benefits of live forests are offset by methane release.
    c. N_2O, HFC's, SFC's: Not applicable
    d. Black carbon: Not applicable

4. Types of Additional Benefits and or Costs, if applicable:
    a. Creation of working lands for sustainable wood products use, recreation, cultural and natural heritage.
    b. Environmental asset protection, including watersheds, wildlife and air quality.

5. Estimated GHG Savings and Costs Per MMTCO$_2$e:
    a. Summary Table of:
        i. GHG potential in 2010, 2020
        ii. Net Cost per MMTCO$_2$e in 2010, 2020
    b. Insert Excel Worksheet and forest calculator showing summary GHG reduction potential and net cost

6. Data Sources, Methods and Assumptions:
    a. Data Sources: Carbon stocks and above ground carbon densities are derived from the Forest Inventory Analysis (FIA) volumetric measurements conducted on a five-year cycle by the USDA Forest Service (Aleric 2004). Land cover change data is provided by FIA data and by the USDA Natural Resource Inventory (NRI), also gathered on a five-year cycle (insert NRI cite). Both data sets are based on a system of numerous state level plots that provide periodic measurements of land cover. Carbon densities for soil carbon are based on recent field estimates (Amichev 2004). Estimates of the portion of cleared biomass converted to commercial wood products and energy recapture, including logging and mill residue generation, are provided by field estimates (Birdsey 1996; Row 1996). Marginal displacement coefficients for avoided energy use are provided by the Energy Supply TWG and are derived from regional National Energy Modeling System (NEMS) data provided by the US Energy Information Administration (EIA) (insert cites).
    b. Quantification Methods: Conversion of volumetric measures of above ground biomass to carbon is based on tree growth equations provided by the USDA Forest Service and standard conversions of live biomass to dry carbon (Birdsey 2003; Matthews 1993). Inflows and outflows of carbon from land clearing and associated practices are identified in a forest carbon calculator provided by CCS that captures all potential inflows and outflows (full life cycle analysis) of above and below ground biomass, as well as harvested wood products, energy recapture, residue recovery and waste biomass. Inflows and outflows of carbon are adjusted as needed for ecological or program risks. This calculator will be attached as a worksheet below.
    c. Key Assumptions: Future stand and tree growth [does/does not] account for risks of land development and or forest health and forest fire.

7. Key Uncertainties if applicable:
    a. Benefits: The rate at which live biomass stocks may decline due to forest health and forest fire risks may be significant. The risk of development effects may also be significant.
    b. Costs: None

8. Description of Indirect Benefits and Costs, if applicable: [delete unless further detail is needed]
    a. [?]

9. Description of Feasibility Issues, if applicable: [delete unless further detail is needed]
    a. [Description of program feasibility issues…]

10. Status of Group Approval [TBD – check one]:
    a. Pending
    b. Completed

11. Level of Group Support [TBD – check one]:
    a. Unanimous Consent
    b. Supermajority
    c. Majority
    d. Minority

12. Barriers to consensus, if applicable (less than unanimous consent): [delete unless further detail is needed]
    a. [?]

13. Draft Policy Option For Discussion: F3a Forest Ecosystem Management – Residential Lands

1. Policy Description:
    a. Lay description of proposed policy action: Manage sustainable thinning or biomass reduction from residential forestlands (intended to address fire and forest health issues) so that harvested biomass is directed to wood products and renewable energy instead of open burning or decay.
    b. Policy Design Parameters:
        i. Implementation level(s) beyond BAU: [x] acres of forestland of [insert forest stand type] thinned by [x number of] cords per treatment.
        ii. Timing of implementation: [insert start/stop dates and intervals of thins].
        iii. Implementing parties: [insert types of land ownerships and governing authorities].
        iv. Other: [specify rate of use of harvested biomass for energy recapture and or durable wood products, or assume market average of current use.]
    c. Implementation Mechanism(s): Indicate which mechanisms are to be used, and briefly describe the specific approach that is proposed [check applicable items, or postpone to future discussion]
        i. Information and education [?], Technical assistance [?], Funding mechanisms and or incentives [?], Voluntary and or negotiated agreements [?], Codes and standards [?], Market based mechanisms [?], Pilots and demos [?], Research and development [?], Reporting [?], Registry [?], Other [?]

2. BAU Policies/Programs, if applicable:
    a. [Describe current residential/municipal fire risk and forest health initiatives oriented toward density reduction.]
    b. [Describe current programs designed to increase market use of small diameter trees for energy and wood products.]
    c. [Describe any relevant programs designed to increase the use of wood products for building materials.]

3. Types(s) of GHG Benefit(s):
    a. CO2: Carbon savings occur when live and dead carbon stocks (trees, shrubs) that otherwise would decay or burn in the forest, or be left for decay and or open burning following harvest, are harvested and converted to: 1) durable wood

products that store carbon; 2) to low embedded energy wood building materials that substitute for high embedded energy conventional building materials (steel and concrete); or 3) to renewable energy that displaces fossil energy use. Sustainable management ensures that replacement biomass grows back to the maximum extent on thinned sites to offset removals of live biomass.

b. CH4: New research (Nature 2006) indicates that about four percent of the carbon storage benefits of live forests is offset by methane release. Methane can be released from land filled biomass under anaerobic conditions.

c. N2O, HFC's, SFC's: Not applicable

d. Black Carbon: Emissions of black carbon (soot) result from combustion of biomass from open burning of land clearing, but the heating effect may be offset by the large emissions of organic material associated with biomass combustion (CCS, 2006).

4. Types of Additional Benefits and or Costs, if applicable:

   a. Protection of residential and or municipal lands from fire risk.

   b. Expansion of markets for industrial producers of sustainable wood products and renewable energy use. Creation of Arizona jobs in the associated forestry management industries.

   c. Environmental asset protection, including watersheds, wildlife and air quality.

5. Estimated GHG Savings and Costs Per $MMTCO_2e$:

   a. Summary Table of:

      i. GHG potential in 2010, 2020

      ii. Net Cost per $MMTCO_2e$ in 2010, 2020

   b. Insert Excel Worksheet and forest calculator showing summary GHG reduction potential and net cost

6. Data Sources, Methods and Assumptions:

   a. Data Sources: Carbon stocks and above ground carbon densities are derived from the Forest Inventory Analysis (FIA) volumetric measurements conducted on a five-year cycle by the USDA Forest Service (Aleric 2004). Land cover change data is provided by FIA data and by the USDA Natural Resource Inventory (NRI), also gathered on a five-year cycle (insert NRI cite). Both data sets are based on a system of numerous state level plots that provide periodic measurements of land cover. Carbon densities for soil carbon are based on recent field estimates (Amichev 2004). Estimates of the portion of cleared biomass converted to commercial wood products and energy recapture, including logging and mill residue generation, are provided by field estimates (Birdsey 1996; Row 1996). Marginal displacement coefficients for avoided energy use are provided by the Energy Supply TWG and are derived from regional National Energy Modeling System (NEMS) data provided by the US Energy Information Administration (EIA) (insert cites).

b. Quantification Methods: Conversion of volumetric measures of above ground biomass to carbon is based on tree growth equations provided by the USDA Forest Service and standard conversions of live biomass to dry carbon (Birdsey 2003; Matthews 1993). Inflows and outflows of carbon from land clearing and associated practices are identified in a forest carbon calculator provided by CCS that captures all potential inflows and outflows (full life cycle analysis) of above and below ground biomass, as well as harvested wood products, energy recapture, residue recovery and waste biomass. Inflows and outflows of carbon are adjusted as needed for ecological or program risks. This calculator will be attached as a worksheet below.

c. Key Assumptions: Forecasted carbon stock measurements from 2002 to 2020 are based on extrapolations of past trends from 1982-2002 and assume a static continuation of all land cover and land use dynamics during that period. New supplies of biomass are assumed to enter the market without resulting in offsetting reduction of other supply sources; new supplies are assumed to expand the market.

7. Key Uncertainties:

   a. Benefits: The market demand for new supplies of wood products and renewable energy is dynamic and not likely to fully absorb all new supply sources without offsetting decreases in other sources without support from policies that expand the market and, potentially, establish preferential treatment of these products in comparison to conventional supplies. The rate of biomass replacement growth in thinned stands is likely to be less than full due to ecological barriers and forest health issues, but the exact rates of replacement are estimated based on expert field judgment.

   b. Costs: Future production cost reductions for wood product development and biomass energy recapture technologies are likely to fall with market expansion and "learning by doing" but are difficult to estimate at this time.

8. Description of Indirect Benefits and Costs, if applicable: [delete unless further detail is needed]

   a. [?]

9. Description of Feasibility Issues, if applicable: [delete unless further detail is needed]
    a. [Description of technology and market feasibility issues…]

10. Status of Group Approval [TBD – check one]:
    a. Pending
    b. Completed

11. Level of Group Support [TBD – check one]:
    a. Unanimous Consent
    b. Supermajority
    c. Majority
    d. Minority

12. Barriers to consensus, if applicable (less than unanimous consent): [delete unless further detail is needed]
    a. [?]

13. Draft Policy Option For Discussion: F3b Forest Ecosystem Management – Other Lands

1. Policy Description:
    a. Lay description of proposed policy action: Increase sustainable thinning of biomass from forests and direct the harvested wood and wood waste to wood products and renewable energy.
    b. Policy Design Parameters:
        i. Implementation level(s) beyond BAU: [x] acres of forestland of [insert forest stand type] thinned by [x number of] cords per treatment.
        ii. Timing of implementation: [insert start/stop dates and intervals of thins].
        iii. Implementing parties: [insert types of land ownerships and governing authorities].
        iv. Other: [specify rate of use of harvested biomass for energy recapture and or durable wood products, or assume market average of current use.]
    c. Implementation Mechanism(s): Indicate which mechanisms are to be used, and briefly describe the specific approach that is proposed [check applicable items, or postpone to future discussion]
        i. Information and education [?], Technical assistance [?], Funding mechanisms and or incentives [?], Voluntary and or negotiated agreements [?], Codes and standards [?], Market based mechanisms [?], Pilots and demos [?], Research and development [?], Reporting [?], Registry [?], Other [?]

2. BAU Policies/Programs, if applicable:
    a. [Describe current forest health initiatives oriented toward density reduction.]
    b. [Describe current programs designed to increase market use of small diameter trees for energy and wood products.]
    c. [Describe any relevant programs designed to increase the use of wood products for building materials.]

3. Types(s) of GHG Benefit(s):
    a. CO2: Carbon savings occur when live and dead carbon stocks (trees, shrubs) that otherwise would decay or burn in the forest are harvested and converted to: 1) durable wood products that store carbon; 2) to low embedded energy wood building materials that substitute for high embedded energy conventional building materials (steel and concrete); or 3) to renewable energy that displaces fossil

energy use. Sustainable management ensures that replacement biomass grows back to the maximum extent on thinned sites to offset removals of live biomass.

b. CH4: New research (Nature 2006) indicates that about four percent of the carbon storage benefits of live forests is offset by methane release. Methane can be released from land filled biomass under anaerobic conditions.

c. N2O, HFC's, SFC's: Not applicable

d. Black Carbon: Emissions of black carbon (soot) result from combustion of woody biomass from open burning of land clearing, but the heating effect may be offset by the cooling effect of this particular type of black carbon (Hansen update).

4. Types of Additional Benefits and or Costs, if applicable:

    a. Protection of working lands and associated industries for sustainable wood products use, recreation, cultural and natural heritage.

    b. Environmental asset protection, including watersheds, wildlife and air quality.

5. Estimated GHG Savings and Costs Per MMTCO_2e:

    a. Summary Table of:

        i. GHG potential in 2010, 2020

        ii. Net Cost per MMTCO_2e in 2010, 2020

    b. Insert Excel Worksheet and forest calculator showing summary GHG reduction potential and net cost

6. Data Sources, Methods and Assumptions:

    a. Data Sources: Carbon stocks and above ground carbon densities are derived from the Forest Inventory Analysis (FIA) volumetric measurements conducted on a five-year cycle by the USDA Forest Service (Aleric 2004). Land cover change data is provided by FIA data and by the USDA Natural Resource Inventory (NRI), also gathered on a five-year cycle (insert NRI cite). Both data sets are based on a system of numerous state level plots that provide periodic measurements of land cover. Carbon densities for soil carbon are based on recent field estimates (Amichev 2004). Estimates of the portion of cleared biomass converted to commercial wood products and energy recapture, including logging and mill residue rates, are provided by field estimates (Birdsey 1996; Row 1996). Marginal displacement coefficients for avoided energy use are provided by the Energy Supply TWG and are derived from regional National Emissions Modeling System (NEMS) data provided by the US Energy Information Administration (EIA) (insert cites).

b. Quantification Methods: Conversion of volumetric measures of above ground biomass to carbon is based on tree growth equations provided by the USDA Forest Service and standard conversions of live biomass to dry carbon (Birdsey 2003; Matthews 1993). Inflows and outflows of carbon from land clearing and associated practices are identified in a forest carbon calculator provided by CCS that captures all potential inflows and outflows (full life cycle analysis) of above and below ground biomass, as well as harvested wood products, energy recapture, residue recovery and waste biomass. Inflows and outflows of carbon are adjusted as needed for ecological or program risks. This calculator will be attached as a worksheet below.

c. Key Assumptions: Forecasted carbon stock measurements from 2002 to 2020 are based on extrapolations of past trends from 1982-2002 and assume a static continuation of all land cover and land use dynamics during that period. New supplies of biomass are assumed to enter the market without resulting in offsetting reduction of other supply sources; new supplies are assumed to expand the market.

7. Key Uncertainties:

   a. Benefits: The market demand for new supplies of wood products and renewable energy is dynamic and not likely to fully absorb all new supply sources without offsetting decreases in other sources, unless there is support from policies that expand the market and, potentially, establish preferential treatment of these products in comparison to conventional supplies. The rate of biomass replacement growth in thinned stands is likely to be less than full due to ecological barriers and forest health issues, but the exact rates of replacement are estimated based on expert field judgment.

   b. Costs: Future production cost reductions for wood product development and biomass energy recapture technologies are likely to fall with market expansion and "learning by doing" but are difficult to estimate at this time.

8. Description of Indirect Benefits and Costs, if applicable: [delete unless further detail is needed]

   a. [?]

9. Description of Feasibility Issues, if applicable: [delete unless further detail is needed]

   a. [Description of technology and market feasibility issues…]

10. Status of Group Approval [TBD – check one]:

a. Pending
b. Completed

11. Level of Group Support [TBD – check one]:
    a. Unanimous Consent
    b. Supermajority
    c. Majority
    d. Minority

12. Barriers to consensus, if applicable (less than unanimous consent): [delete unless further detail is needed]
    a. [?]

Draft Policy Option For Discussion: F4 Improved Commercialization of Biomass Gasification and Combined Cycle

1. Policy Description:
    a. Lay description of proposed policy action: Accelerate the rate of technology development and market deployment of biomass gasification technologies.
    b. Policy Design Parameters:
        i. Implementation level(s) beyond BAU: [x percent] increase in biomass generation capacity for direct heat and electricity generation.
        ii. Timing of implementation: [x] new BTU's of biomass energy from [insert start/stop dates] including any necessary ramp up period.
        iii. Implementing parties: [insert types of producers, consumers and governing authorities that may be affected].
        iv. Other: [define technology standards for new biomass gasification.]
    c. Implementation Mechanism(s): Indicate which mechanisms are to be used, and briefly describe the specific approach that is proposed [check applicable items, or postpone to future discussion]
        i. Information and education [?], Technical assistance [?], Funding mechanisms and or incentives [?], Voluntary and or negotiated agreements [?], Codes and standards [?], Market based mechanisms [?], Pilots and demos [?], Research and development [?], Reporting [?], Registry [?], Other [?]

2. BAU Policies/Programs, if applicable:
    a. Description of any existing technology or market development programs for biomass gasification…

3. Types(s) of GHG Benefit(s):
    a. CO_2: Carbon savings occur when biomass energy combustion processes are converted from conventional technology to new technologies with greater thermal efficiency and lower pollution outputs. New conversion technologies also may expand the use of available biomass supplies that substitute biomass energy for conventional fossil fuels.
    b. CH_4: New research (Nature 2006) indicates that about four percent of the carbon storage benefits of live forests is offset by methane release. Methane can be released from land filled biomass under anaerobic conditions.
    c. N_2O, HFC's, SFC's: Not applicable

d. Black Carbon: Emissions of black carbon (soot) result from combustion of woody biomass from open burning of land clearing, but the heating effect is likely to be offset by the cooling from the large amount of organic material emitted from biomass combustion (CCS, 2006).

4. Types of Additional Benefits and or Costs, if applicable:

   a. Criteria air pollution levels are lower with advanced technology.

   b. Expansion of markets for industrial producers of sustainable wood products and renewable energy use. Creation of Arizona jobs in the associated forestry management industries.

5. Estimated GHG Savings and Costs Per $MMTCO_2e$:

   a. Summary Table of:

      i. GHG potential in 2010, 2020

      ii. Net Cost per $MMTCO_2e$ in 2010, 2020

   b. Insert Excel Worksheet and forest calculator showing summary GHG reduction potential and net cost

6. Data Sources, Methods and Assumptions:

   a. Data Sources: Marginal displacement coefficients for avoided energy use are provided by the Energy Supply TWG and are derived from regional National Emissions Modeling System (NEMS) data provided by the US Energy Information Administration (EIA) (insert cites).

   b. Quantification Methods: Inflows and outflows of carbon from land clearing and associated practices are identified in a forest carbon calculator provided by CCS that captures all potential inflows and outflows (full life cycle analysis) of biomass energy recapture. This calculator will be attached as a worksheet below.

   c. Key Assumptions: New supplies of biomass are assumed to enter the market without resulting in offsetting reduction of other supply sources; new supplies are assumed to expand the market.

7. Key Uncertainties:

   a. Benefits: The market demand for new supplies of renewable energy is dynamic and not likely to fully absorb all new supply sources without offsetting decreases in other sources without support from policies that expand the market and, potentially, establish preferential treatment of these products in comparison to conventional supplies.

   b. Costs: Future production cost reductions for biomass energy recapture technologies is likely to fall with market expansion and "learning by doing" but are difficult to estimate at this time.

8. <u>Description of Additional Benefits and Costs, if applicable:</u>
   a. Description of issue #1
   b. Description issue #2
   c. Etc.

9. <u>Description of Feasibility Issues, if applicable:</u>
   a. Description of technology and market feasibility issues…

10. <u>Status of Group Approval:</u>
    a. Pending
    b. Completed

11. <u>Level of Group Support:</u>
    a. Unanimous Consent
    b. Supermajority
    c. Majority
    d. Minority

12. <u>Barriers to consensus, if applicable (less than unanimous consent):</u>
    a. Description of barrier #1
    b. Description of barrier #2
    c. Etc.

FOREST CARBON CALCULATIONS

The table below describes important components of full life cycle carbon accounting for forestry mitigation options and will be followed by an accounting template for analysis of greenhouse gas reductions.

Data Input	Description
Acres Treated	Specified by TWG proposals as cumulative acreage, by forest type, over a specified number of years, and also translated into an average annual number
Harvest Method And Intensity	Specified by TWG proposals
Regeneration Method And Intensity	Specified by TWG proposals, or by default with biomass replacement assumed to occur completely over [x] years (the average age of forested stands in AZ as measured by FORCARB)
Percent Harvested Biomass Directed To/From Energy Recapture Vs. Wood Products	Specified by TWG proposals or by default using HARVCARB averages
Percent Biomass Directed To/From Pulp Vs. Saw Timber	Specified by TWG proposals or by default using HARVCARB averages
Disposition Rates Of Harvested Biomass To/From: • **Wood Products** • **Landfill Storage** • **Waste Emissions** • **Energy Emissions**	HARVCARB regional data applied to AZ FORCARB data A weighted average based on FORCARB results is used for average stands unless otherwise specified
Estimated Forest Carbon In Biomass	FORCARB as revised with best available state data Carbon replacement of natural stands uses 2002 AZ FORCARB data, adjusted by risk factors as needed

Volume And Decay Of Logging Residue	Estimates of non merchantable biomass volume from Turner (1993) as reported in Sampson and Hair (1995); intermediate harvest rates used
Carbon Decay Rate Of Forest Floor And Coarse Woody Debris	Currently not quantified, but can be increased by intensive harvest levels and certain harvest methods – see Yanai (2003)
Mortality Rate Of Undisturbed Stands	Currently not quantified, but can be reduced by density management (thinning)
Electric Power Displacement From Biomass Feedstocks	Marginal displacement rate of [x] pounds per MWh provided by NEMS
GHG Displacement From Wood Products That Substitute For Building Materials	Data from Bowyer (2003) from CORIMM using case studies from Minneapolis and Atlanta Combined effect of steel and concrete energy displacement = 28.7 percent of biomass carbon in wood products that substitute
Sustainability Constraints	Long term biomass growth estimates assume sustained acreage levels, no unnatural disturbance, complete regeneration of harvested biomass unless otherwise specified Thinning, light and selective harvests assume minimal disturbance to forest floor and coarse woody debris
Levelized, Annual Greenhouse Gas Savings	Forestry options propose a cumulative number of acres be treated over a [x] year period. To calculate a representative (or average) year, the cumulative [x] year acreage is calculated as if it were treated in the middle year to give average annual results. No ramp-up periods are specified unless otherwise noted.
Discounting	Emissions and emissions reductions are not discounted.

	Costs assume a 5 percent discount rate.
Time Periods	Method One: 2005-2020, no benefits or costs counted beyond 2020 Method Two: 2005-2020, addition of benefits and costs that accrue by 2100 as a direct result of actions taken between 2005-2020. Biomass replacement of harvested stands is calculated over [x] years to match average stand age in AZ. HARVCARB wood products effects are calculated to 2100. These are added to annual savings in 2005-2020 to show full life cycle effects.

REFERENCES CITED

Alerich, C.L., L. Klevgard, C. Liff, and P.D. Miles. 2004. The forest inventory and analysis database: Database description and users guide version 1.7. USDA Forest Service. December 21, 2004. Available online at <http://ncrs2.fs.fed.us/4801/fiadb/fiadb_documentation/FIADB_v17_122104.pdf> (May 9, 2005)

Amichev, B.Y., and J.M. Galbraith. 2004. A revised methodology for estimation of forest soil carbon from spatial soils and forest inventory data sets. Environmental Management 33: S74-S86.

Birdsey, R.A. 1996. Carbon storage for major forest types and regions in the coterminous United States. p. 1-25 and Appendix 2-4. *In* N. Sampson and D. Hair, (eds.) Forests and Global Change. Volume 2: Forest management opportunities for mitigating carbon emissions. American Forests. Washington, DC.

Birdsey, R.A., and G.M. Lewis. 2003. Carbon in U.S. forests and wood products, 1987-1997: state-by-state estimates. USDA Forest Service, Northeastern Research Station General Technical Report NE-310, Newtown Square, PA.

CCS, 2006. Bailie, A., M. Lazarus, T. Peterson, K. Hausker, P. Kuch, E. Williams, K. Colburn, and S. Roe, *Arizona Greenhouse Gas Inventory and Reference Case Projections 1990-2020*, The Center for Climate Strategies, prepared for the Arizona Department of Environmental Quality, February 2006.

Row, C., and R.B. Phelps. 1996. Wood carbon flows after timber harvest. p. 27-58. *In* N. Sampson and D. Hair, (eds.) Forests and Global Change. Volume 2: Forest management opportunities for mitigating carbon emissions. American Forests. Washington, DC.

Nature article…

NEMS…

NRI…

Others TBD

REFERENCES NOT CITED

Heath, L.S., J.E. Smith, and R.A. Birdsey. 2003. Carbon trends in U.S. forestlands: A context for the role of soils in forest carbon sequestration. Chapter 3, p. 35-45. *In* J.M. Kimble, L.S. Heath, R.A. Birdsey, and R. Lal (eds.) The potential of US forest soils to sequester carbon and mitigate the greenhouse effect. CRC Press, Boca Raton, FL.

Matthews, G. 1993. The carbon content of trees. Forestry Commission Technical paper 4, Forestry Commission, Edinburgh, UK. 21p.

Penman, J., et al., eds. 2003. Good practice guidance for land use, land use change and forestry. Published by the Institute for Global Environmental Strategies for the Intergovernmental Panel on Climate Change. Available online at <http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.htm> (May 9, 2005)

Smith, J.E., L.S. Heath, and P.B. Woodbury. 2004. How to estimate forest carbon for large areas from inventory data. Journal of Forestry 102:25-31.

Smith, W.B. 1991. Assessing removals for North Central forest inventories. USDA Forest Service, North Central Forest Experiment Station Research Paper NC-299, St. Paul, MN.

Smith W.B., P.D. Miles, J.S. Vissage, and S.A. Pugh. 2004 Forest resources of the United States, 2002. USDA Forest Service, North Central Research Station General Technical Report NC-241, St. Paul, MN.

West, T.O., G. Marland, A. King, W.M. Post, A.K. Jain, and K. Andrasko. 2004. Carbon management response curves: estimates of temporal soil carbon dynamics. Environmental Management 33: 507-518.